Remarks

Drawing objections.

The Examiner has objected to the drawings as set forth in sections 2-1, 2-2 and 2-3 of the Detailed Action.

The amendment of the paragraph at lines 5-11 of page 26 of the specification is believed to meet objection 2-2. The welding gun depicted in Figures 7-11 has been referred to by reference numeral 46 (not 40) throughout the specification and the text at lines 6 and 9 has been corrected by this amendment.

Figure 12 of the Drawings has been amended to correct the spelling of POUNCE to meet objection 2-3.

In Section 2-1, the Examiner has asserted that the drawings must show the methodology of the claimed processes or the process steps must be cancelled. The Examiner is respectfully requested to reconsider this objection and requirement for the following reasons.

Claims 1-9 recite methods of arranging one or more workpiece and workpiece processing devices in a manufacturing cell using a programmable computer and a database. As the title of the application states, the methods achieve a computer-aided layout of a manufacturing cell.

The computer-aided and executed method steps involve entering several types of specified numerical data into a computer. The data includes, e.g., numerical geometric descriptions of the manufacturing cell, the workpieces and the workpiece(s) processing device(s) and data concerning their positions, orientation and range of motion of their joints. Identifications of attracting and repelling pairs are entered into the database and, ultimately, a mathematical optimization analysis is applied to a mathematical potential function to achieve an arrangement of the workpiece(s) and device(s) in the cell so that attracting pairs are coincident and repelling pairs are separated.

The processing is fully described in the text of the specification and there is no doubt that one skilled in the art could practice the invention from the textual description. The addition of a drawing would only amount to presenting simplified statements of the generally mathematical steps as, for example, a block flow diagram. But the patent

statute doesn't require drawings to summarize method steps clearly described in the text of the specification. Thousands of patents describing and claiming method inventions don't contain such drawings. Applicant has used drawing figures to illustrate an example of the operation of the claimed processes in the securing and welding of automotive panels. But it is respectfully urged that no additional drawing figures are required to disclose the methodology of the claimed process steps. The written specification fully discloses the claimed subject matter.

The Specification.

The Examiner has requested a copy of the Paul reference which is a textbook. Instead of sending the entire textbook, applicant encloses a copy of the applicable pages of the Paul text. The Selig textbook is also identified at page 14 of the specification. Applicable portions of this textbook are also enclosed. These materials disclose the matrix transformations referred to in this specification at page 14.

The Examiner has also requested a copy of the Orin and Shrader article referred to a page 22 of the specification, and a copy of that publication is enclosed with this response.

Rejection under 35 U.S.C. 112.

Claims 1-9 are rejected under the second paragraph of 35 U.S.C. 112 for lack of clarity at lines 24-25 of independent claim 1. Claim 1 has been amended as suggested by the Examiner and it is believed that this basis of rejection of the claims has been corrected.

Claim rejections under 35 U.S.C. 103 (a)

Claims 1-3 and 8-9 are rejected as being unpatentable over Matsuzaki et al, U.S. Patent 5,357,439, and applicant's statement at lines 18-19 of page 13, in view of the Spector patent, U.S. 6,004,016. Claim 4 is rejected over the same combination of patents and applicant statement. Claims 5-7 are rejected over the combination of Matsuzaki et al, Spector and the Tandler patent U.S. 5,949,693. The Examiner is requested to reconsider these rejections for the following reasons.

Summary of the claimed invention.

Before commenting on the content of the Matsuzaki, Spector and Tandler patent disclosures it may be helpful to summarize characteristics of the computer-aided manufacturing cell layout method(s) as defined in claims 1-9.

1) The method treats a manufacturing cell that has multiple robots, workpieces, fixtures, clamps, etc., all generically referred to as "devices," working in the same manufacturing cell volume.

2) The locations of all or any subset of the devices can be specified to be included in an optimization to find a collision-free layout for each of a series of manufacturing operations. The resulting layout is such that there are no collisions at each step in the sequence of operations. However, as stated at page 2 of the application, the creation of collision-free motions of the devices being re-located between different manufacturing operations (on the same or different workpieces) is a secondary problem, outside the scope of this invention.

3) Any or all of the components of position and orientation of the location of the devices can be designated as fixed or free for the purpose of optimization.

4) The optimization encompasses the entire sequence of operations to be performed in the manufacturing cell and, importantly, can span several different sequences that will be performed to build different products in the same cell. The optimization seeks a layout that is collision free at every step within each sequence.

5) All the constraints of the layout problem are gathered into one mathematical potential function summed over all devices and all steps in each sequence of operations. The potential function includes attracting pairs, repelling pairs and joint-limit potentials.

6) The method is embedded in an interactive computer graphical environment that allows the user to edit all the elements making up the potential function, the list of variables to be optimized, and the initial values of all these variables, and then re-run the optimization.

7) If the user opts to build up the work cell by introducing devices one at a time, or more than one at a time but in several stages, the devices already placed can be allowed to move to make room for the new devices.

Specifically, the methods use numerical data for the manipulation and evaluation of the positions and possible range of motions of workpieces and processing devices. The methods design the layout of workpieces and devices by making use of the concepts of "attracting pairs" which are to be brought into coincidence and "repelling pairs" which are to be kept apart. The methods use a mathematical potential function, as described at pages 11-13 of the specification, for assessing potential movements in arriving at a manufacturing cell layout for a particular job. And the practice is to optimize the manufacturing cell layout by minimizing the potential function as taught at pages 21-24.

The specification states that such computer based process steps may be performed using commercially available software. Software is available for digitally manipulating geometric positions and kinematics. Software is available for performing optimization operations. But this does not mean that the software discloses the claimed process or makes it obvious. Applicant is not aware of any prior disclosure or teaching of the subject claimed method for layout of a manufacturing cell.

The Matsuzaki Patent Disclosure.

Matsuzaki et al is the primary reference applied by the Examiner in rejecting each of claims 1-9. But this reference does not disclose or suggest applicant's method.

Matsuzaki discloses a manufacturing system for receiving custom orders and organizing the manufacture of the requested item. It is an omnibus disclosure of receiving an order, designing a part, organizing a way of assembling the part and gathering machines for the assembly. But the organization of the manufacturing operation is done by the practitioner recalling computer-stored data and organizing the workplace by visual computer screen image and manipulation. Data concerning the assembly of the part and the motions of the machines to be used are displayed on a screen and the computer operator user of the process positions them. For example, at column 26, lines 22-56:

As a method for selecting one of those solutions, as shown in FIG. 38, **there is considered the method of displaying the information for aiding a user's decision on the display unit and determining the proper solution in an interactive manner.** For example, in selecting the machine/tool, it is considered to display the usage frequency and the working ratio together with the candidate solutions for aiding the user's decision.

In defining the layout, as shown in FIG. 44, **the user may process in an interactive manner while viewing the screen.**

FIG. 44 shows the assembling operation with the robot. In this Figure, in addition to the robot, the table, and the parts, the operating range and the moving interval of the robot are displayed in a three-dimensional manner. **The user can change the installation location of the robot with an input means such while a mouse as viewing the screen.**

With the change of the installation location of the robot, the operating range is changed accordingly. For checking if any robot-installed apparatus is capable of doing any assembling operation, it is necessary to calculate the inclusive relation between the operating range and the moving interval and separate the displaying manner of the operating range from that of the area outside of the operating range (according to the color or luminance variation, for example).

This method can be realized in each assembling operation or can be used for checking the assembling interval relevant to the assembling operation of the overall product.

The menus shown in the right lower part of FIG. 44 are provided to support the change of view and the rotation and linear movement of the graphics, which are operated with the mouse being clicked. (emphasis added).

This is the thrust of the Matsuzaki et al disclosure. They do not contemplate applicant's numerical approach to manufacturing cell layout which is not based on computer operator trial and error manipulation.

There is no suggestion in the Matsuzaki patent of using the concepts of attracting pairs, repelling pairs, potential functions and optimization calculations for manufacturing cell layout. The Examiner has simply parsed the paragraphs of claims 1-9 and extracted isolated phrases from throughout the several columns of the Matsuzaki patent to try to synthesize the substance of the claimed invention. But Matsuzaki doesn't disclose, in any manner, the substance of claims 1-9. Furthermore, the nature of the complete overview of the Matsuzaki process doesn't invite application of the secondary

patent references, Spector and Tandler, applied by the Examiner. There is no proper technical basis to go from the Matsuzaki disclosure to patent disclosures like Spector and Tandler because Matsuzaki doesn't contemplate computer-aided, math-based location of workpieces and moving machine elements. Matsuzaki inputs the images and movements of the machine and his process user visually observes them and manipulates them on a computer screen.

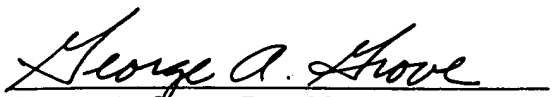
The Spector and Tandler Patent References.

The Spector patent describes the concept of repelling pairs in evaluating the movement of workpieces and their manipulators. But Spector does not disclose the processes of claims 1-9, nor does Spector suggest the possibility of such a manufacturing cell layout process. The combination of Spector with Matsuzaki rejection of claims 1-9 is without basis because Matsuzaki et al do not use a numerical methods involving optimization of potential functions for manufacturing cell layout.

The Tandler patent treats the relationships between coordinate systems by constraining one, two or three points to coincide. But the processes of the subject claims 5-7 use distances between points as a means of defining attractive pairs and repelling pairs, with other variables, in a potential function as the objective for an optimization process for manufacturing cell design. Tandler doesn't teach such methods, nor does the combination of Tandler with Spector and Matsuzaki et al.

It is respectfully submitted that the specification is in order and that the claims 1-9 define a patentable method for manufacturing cell layout. Accordingly, it is respectfully requested that the rejection of the claims be reconsidered and that they be allowed and the case passed to issue.

Respectfully Submitted,



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I hereby certify that this correspondence is, on the date shown below, being deposited with the United States Postal Service with sufficient postage as first class mail, in an envelope addressed to the Commissioner of Patents and Trademarks, Washington, D.C. 20231 on : June 10, 2003

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